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Article

Strategic Motivation of China's Space Technology Rise: From Dependence to Independence under Xi Jinping

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Abstract

This study investigates the rapid advancement of China's space technology during the Xi Jinping era, emphasizing the factors that transformed China from a latecomer to a leading space power. Since Xi Jinping took office in 2013, China has pursued an ambitious commercialization strategy for space technology, aligning it with broader national objectives, such as the "great rejuvenation of the Chinese nation." This study highlights China's major achievements in lunar exploration, Martian missions, and space station construction, and its strategic intent to reshape the existing international order. Key factors behind China's progress include the prioritization of space as the "commanding height of international strategic competition" and the promotion of private sector involvement in the space industry. Additionally, this study emphasizes China's focus on technological self-reliance in response to United States restrictions. By analyzing these factors, this study illustrates how China has rapidly emerged as a global leader in space technology, reshaping the dynamics of international space competition.

Keywords

China's space technology, U.S.-China Space Competition, Technological self-reliance, Space technology commercialization

Introduction

A critical aspect of Sino-American space competition is the technological rivalry for achieving supremacy in space technology and strategic dominance in outer space. This rivalry has the potential to escalate tensions between the two nations, raising significant concerns about the militarization of space. Both the United States and China view space as an essential domain for national security and remain cautious about its potential military applications. Consequently, any unilateral effort by a nation to establish military superiority in space is likely to provoke countermeasures and heighten tensions, contributing to instability in the international space order.

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Since Xi Jinping's inauguration in 2013, China has embarked on significant commercialization of its space technology, progressively expanding its capabilities. Xi's leadership is characterized by a comprehensive strategy that emphasizes a proactive approach not only in geopolitics but also in the domain of space, aligning with the broader national ambition of the "great rejuvenation of the Chinese nation" (Goldstein, 2020: 164–201). This strategic direction underscores China's intent to challenge the existing international order and assume a leading role on the global stage, particularly in space exploration, satellite technology, and the militarization of space for national security. To this end, China has made the development of its space technology and industry a top priority, implementing substantial investments and policy initiatives. This focus has intensified since the introduction of 2014 guidelines encouraging private-sector participation in the space industry. As a result, under Xi Jinping's leadership, China achieved significant milestones in lunar exploration, Mars missions, and the construction of the Tiangong Space Station, solidifying its status as a leading global player in the space sector.

China's full-fledged "space dream" became apparent in the 2015 Defense White Paper, which designated space as the "commanding heights of international strategic competition," underscoring its ambition to expand its influence in outer space and achieve military superiority. Following this declaration, China initiated the development of space-based C4ISR (Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance) capabilities—where C4 represents Command, Control, Communications, and Computers, and ISR represents Intelligence, Surveillance, and Reconnaissance. By advancing sophisticated launch vehicles, satellite navigation systems, antisatellite technologies, and manned space missions, China has made significant strides in the development of space technology. Thus, Xi Jinping's leadership era has been marked by substantial progress toward technological superiority and strategic dominance in the space domain, establishing China as a pivotal player in global strategic affairs.

These developments raised substantial concerns in the United States regarding the prospect of being overtaken, leading to the establishment of the United States Space Force by the Trump Administration in December 2019 (Garamone, 2019). In response, General Stephen Whiting, Commander of the U.S. Space Command, stated at a Senate Armed Services Committee hearing on February 29, 2024, that China's rapid development of space-related military capabilities could eventually position it as the United States' primary space competitor and a potential threat in space (Chen, 2024). Vice Commander David Thompson similarly projected that without adequate resource allocation, China could surpass U.S. space capabilities by 2030 (Fisher & Swire, 2021). Additionally, the U.S. Office of the Director of National Intelligence recognized China's innovative developments, noting that "China is advancing systems across all space technology fields and is poised to reach world-class status in nearly every area by 2030" (Office of the Director of National Intelligence, 2021).

Chinese Ministry of National Defense spokesperson Zhang Xiaogang countered that the U.S. was the primary instigator in expanding military power related to space and threatening space security. He emphasized that China opposes an arms race in space and is committed to the peaceful utilization of space (Chinese Ministry of National Defense, 2023). China argues that the U.S. initiated the militarization of space, citing intensified U.S. activities since the 1980s and the establishment of the U.S. Space Force in 2019 as evidence. China maintains that its space technology development is defensive, countering the U.S. military space activities that pose a threat to China and other nations (Blanc et al., 2022).

Nevertheless, China's ambitions in space were explicitly highlighted in a 2023 report by the U.S. Department of Defense titled "Military and Security Developments Involving the People's Republic of China" (Office of the Secretary of Defense, 2023). While China officially promotes agreements related to the demilitarization of space at the United Nations, it persistently enhances its space weapon capabilities. Between 2015 and 2018, China doubled its satellite fleet and participated actively in space races (Erwin, 2022; Pope, 2021). Notably, 2023 was a record-breaking year for China's space endeavors, with 67 launches and the successful placement of 66 in orbit, deploying 210 payloads into space (McDowell, 2024a: 4–9).

Since Xi Jinping's ascent to leadership in 2013, China has proactively developed space technology undeterred by U.S. restrictions. Institutional reforms and self-reliance are central to these efforts. Since 1999, U.S. export controls—aimed at preserving U.S. dominance in the space industry—have effectively prevented China from accessing foreign satellite technology. This policy was intended to limit the proliferation of space capabilities, thereby maintaining U.S. supremacy. While this approach initially restricted China's access to cutting-edge technologies, it ultimately fostered a drive toward indigenous innovation (Noble, 2008: 251–312).

Ironically, U.S. sanctions spurred China to intensify its focus on self-reliance in space technology. Until the Hu Jintao era, China's space efforts were largely experimental, but under Xi Jinping's leadership, they entered an operational phase (Eastin, 2023). By leveraging indigenous technologies, China advanced in satellite meteorology, manned spaceflight, robotic exploration, intelligent satellite networks, and space station construction. It also enhanced its ability to monitor, track, and target the orbital activities of the U.S. and its allies. These achievements have solidified China as a leading space power and positioned it as the United States' principal competitor, reshaping the landscape of international space competition.

Given this context, this study examines the strategic motivations and policies that drove China's rapid advancement in space technology under Xi Jinping's leadership, particularly its efforts to overcome U.S. restrictions. It explores how China's emphasis on self-reliance, combined with the integration of private-sector participation, enabled the country to emerge as a global power. This analysis focuses on how China, initially a latecomer in space technology compared to the U.S. and Russia, managed to reach a comparable level of development within a relatively short period and identifies the key factors contributing to this progress.

China's Space Technology Development under Xi Jinping

Rapid Advancement of China's Space Launch Vehicle Technology

China's space industry has emerged as one of the most dynamic industries in the world, achieving milestones previously accomplished only by the U.S. and Russia. Since its first manned spaceflight mission in 2003, China has operated the Tiangong Space Station. The nation has also executed robotic lunar explorations, becoming the first to explore the far side of the Moon, and has undertaken Martian exploration missions. In addition, China has established a global satellite navigation system and a 24-hour, all-weather Earth remote-sensing system (Pollpeter, 2023: 114–128). These achievements underscore the significant role of space-launch vehicle technology as a crucial indicator of China's space development, reflecting its scientific, economic, and military capabilities. Space-launch vehicles are essential because they facilitate successful placement of payloads in orbit. Given the advanced technology and substantial financial resources required, countries with indigenous launch vehicle technology are often reluctant to transfer them, leading most nations to rely on the capabilities of established space powers. However, after prolonged efforts, China succeeded in placing all its satellites in orbit using its own launch vehicles (Chinese National Space Administration, 2021a; Jones, 2021; State Council Information Office of the People's Republic of China, 2022; Xinhua, 2024).

China is advancing key space missions through the development of powerful launch vehicles, such as the Long March 5 and the forthcoming Long March 9 rockets. Long March 5, China's largest rocket to date, successfully executed Martian exploration and lunar sample return missions. Long March 9, currently under development as a superheavy-lift launch vehicle, aims to support China's goal of establishing a lunar base by 2030. The development of powerful launch vehicles has been pivotal in enabling China to achieve its space exploration objectives and demonstrate independent innovation capabilities in the space industry (Deng, 2024; Goswami, 2023; Wang, 2023). Space-launch vehicles monopolize access from Earth to outer space, playing an essential role in transporting critical payloads, such as satellites, space probes, and space station components, into orbit and beyond. This technology lays the foundation for space science research and exploration missions. Successful launches of Mars rovers, interplanetary probes, and space telescopes largely depend on the performance of launch vehicles. The deployment of commercial, communication, and navigation satellites directly impacts economic benefits and national security, necessitating precision in launch vehicle technology. Space-launch capabilities symbolize a nation's ability to explore and operate in space, representing its technological, scientific, and military status in international space competition and cooperation. The development and innovation of launch vehicle technology has promoted technological advancements in the broader field of space technology, and advancements such as reusable rockets, lightweight materials, and improved propulsion systems can reduce the cost of space exploration and enhance efficiency.

Historically, the Soviet Union's successful launch of Sputnik 1 in October 1957 initiated global competition for satellite launches. The U.S. followed the Soviet Union's efforts with Explorer 1 in January 1958. Other nations such as France and Japan joined the space age in the 1960s and '70s. In April 1970, China launched the Dong Fang Hong 1, becoming the fifth nation to place satellites in orbit using indigenous technology (Maini & Agrawal, 2011; Space.com, 2012; U.S. Department of State, 1957).

During the Cold War, space activities were dominated by the U.S. and Soviet Union. Between 1957 and 1991, the Soviet Union successfully launched 2,309 rockets, more than twice the 938 launches by the U.S. During this period, China launched 28 rockets. However, this trend shifted after the collapse of the Soviet Union. Since 1992, Russia's annual rocket launches have decreased significantly, whereas China has begun to increase its launch frequency (Center for Strategic and International Studies, 2024).

Although China entered the space age in 1970, internal factors, such as the Cultural Revolution and a focus on economic development, delayed significant progress in space technology until the 1990s. In 1992, China adopted Project 921, which established manned spaceflight as a medium- to long-term goal. During this period, China undertook ambitious space missions, including technological exchanges with Russian space agencies. In 1999, the Shenzhou spacecraft, carrying biological samples, successfully orbited the Earth and returned (New Scientist & AFP, 2005). The number of space rocket launches in China has rapidly increased since the 2000s. In 2010, China matched the U.S. with 15 launches, and surpassed it in 2011 with 18 launches. Between 2010 and 2019, China conducted 207 launches, far exceeding the total number of launches over the previous 40 years. In 2018, China executed 39 rocket launches, the highest number by any country in a single year at that time. This trend continues, with 39 launches in 2020, 55 in 2021, and 64 in 2022 (China National Space Administration, 2022; McDowell, 2024b).

In the post–Cold War era, China emerged as a major actor in the space race. The increasing number of launches and advancements in space technology have significant implications for global politics by influencing international relations, security dynamics, and economic competitiveness in the space sector.

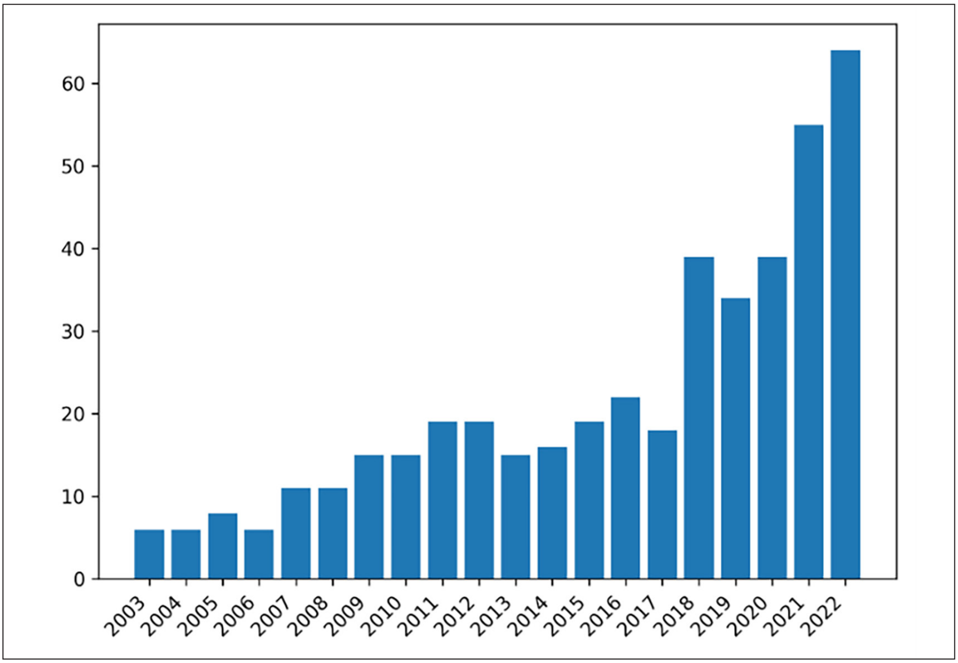

Figure 1. Number of Space Launches by China (2003–2022)
Source: China National Space Administration (2022); McDowell (2024b).

As shown in Figure 1, during the Hu Jintao era, the number of space launches in China gradually increased. However, the growth rate expanded significantly during the Xi Jinping era. In particular, the number of launches began to increase rapidly in 2018, reaching 64 in 2022. This trend highlights China's significant advancements in space technology and launch capabilities, driven by its active promotion of diverse space programs, including space exploration, commercial satellite launches, and international space station projects. This progress has been notably accelerated by strong space policies and the strategic support of Xi Jinping's leadership.

China's space program is closely linked to domestic politics, supporting various national objectives, such as economic development, security, and the enhancement of national pride. Xi Jinping's emphasis on space exploration has contributed to fostering nationalism and strengthening domestic political support (Kuo, 2021).

Increase in Space Payloads and Technological Advancement

Although the development of space launch vehicles is a significant measure of technological space advancements, payloads, including satellites and spacecraft, represent another crucial aspect. The increase in the number of payloads in tandem with advancements in rocket technology can be viewed as an indicator of enhanced space capabilities. For instance, the practical application of space technology, such as communication satellites and navigation systems, necessitates the development and deployment of payloads, and only a few countries have the capability to launch payloads into space.

Over the past two decades, China has made considerable technological progress in the space domain, resulting in reliable launch capabilities that can swiftly deploy payloads to various orbits.

This technological advancement can be attributed to China's strategic emphasis on space for civilian and military purposes. Therefore, several factors support the assertion that an increase in space launch payloads indicates advancements in space technology.

The ability to launch multiple payloads simultaneously highlights progress in rocket technology. For example, SpaceX's Falcon 9 and Falcon Heavy have successfully launched numerous satellites in a single mission. In addition, technological advancements have reduced launch costs, enabling more countries and private companies to conduct space launches, leading to the deployment of more payloads. Moreover, the development of small-satellite technologies, such as CubeSats, allows for the launch of more payloads using smaller rockets. Small satellites can perform various experiments and missions at low cost, prompting more organizations to utilize them. Furthermore, the increase in private space companies has resulted in the launch of more payloads, including satellites, for commercial purposes such as communication and observation. This growth is linked to the overall expansion of the space industry, which is underpinned by technological advancement. Finally, technological progress leads to higher launch success rates, allowing more payloads to safely reach space (NASA, 2024; National Research Council et al., 2000; U.S. Government Accountability Office, 2000).

Notably, under Xi Jinping's leadership China made significant strides not only in space launch capabilities but also in payload technology. Since 1957, China has been launching payloads into the Earth's orbit and is one of the few countries possessing indigenous technology in this field. The payloads primarily include satellites, space probes, and manned or unmanned spacecraft. Spacecraft are vehicles used to transport humans or objects, while space probes are unmanned spacecraft designed for scientific purposes. Satellite payloads are classified by their functions, including electro-optical payloads (such as the Advanced Earth Imaging Sensor System), synthetic aperture radar payloads, infrared payloads, communication payloads, meteorological payloads (e.g., Advanced Meteorological Imager), oceanographic payloads (e.g., geostationary ocean color imager), and environmental payloads (e.g., Geostationary Environmental Monitoring Spectrometer).

The most common payloads launched into space are Earth-orbiting satellites, which provide numerous functions, such as communication, navigation, and Earth observation. During the Cold War, the Soviet Union launched 2,791 payloads into space, more than double the 1,193 payloads launched by the U.S., and over 10 times the number from the rest of the world. As of March 2020, 2,666 known satellites were in orbit. Of these, 13.6% (363 satellites) were owned or operated by Chinese entities, more than double Russia's 169 satellites. The U.S. maintains 1,327 satellites, accounting for approximately half of all known satellites in orbit (China Power, 2019).

In 2021, Xi presented a vision for China's space program, stating that exploring the vast universe, developing the space industry, and making China a space power were China's dreams (State Council Information Office of the People's Republic of China, 2022). This vision indicates that space exploration and technological development are significant strategic priorities for China. For example, China launched the Jielong-3 rocket, a small yet powerful vehicle capable of carrying payloads at competitive costs. This launch successfully placed nine satellites in orbit, paving the way for additional commercial space missions in China. The success of Jielong-3 demonstrates China's growing capabilities in space launch technology and its potential to capture a large share of the global satellite launch market (China National Space Administration, 2022; Woo, 2024).

Figure 2 illustrates the trends in China's space technology development. In 2007, China had 39 satellites in orbit. However, as of May 1, 2023, out of a total of 7,560 satellites, China possesses 628 satellites, second only to the U.S. with 5,184 satellites, surpassing Russia's 181 satellites. Globally, there are 6,768 satellites in a Low Earth Orbit, 143 in a Medium Earth Orbit,

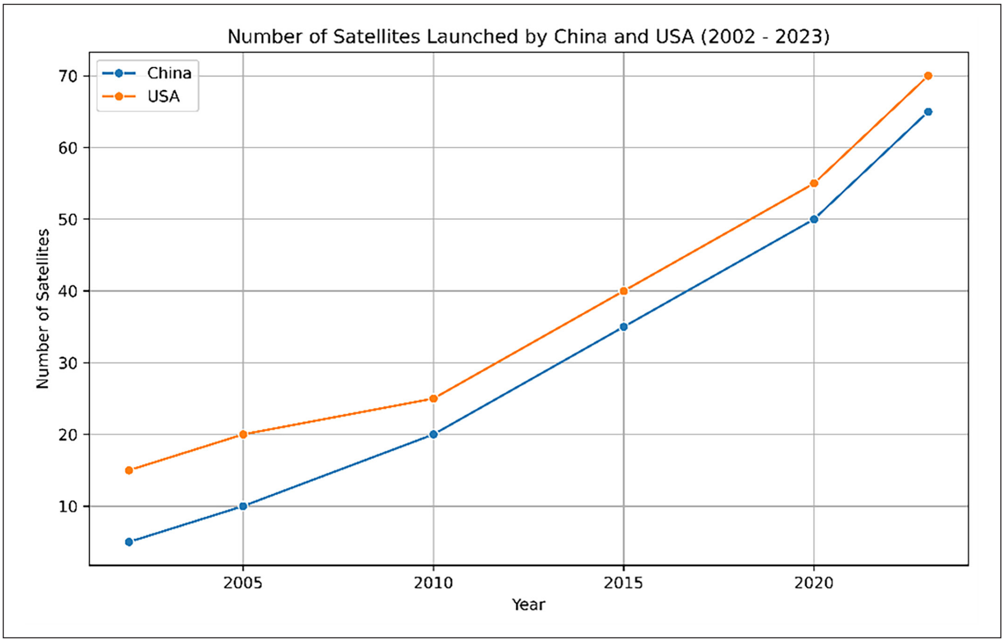

Figure 2. Number of satellites of the U.S. and China (2022–2023)
Source: *Reconstructed from Union of Concerned Scientists Satellite Database, Satellite Quick Facts, May 1, 2023.*

Table 1. Number of launches and payloads of China and the U.S. (2003–2019)

Year		03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19
China	Launches	6	12	5	6	7	11	6	15	18	18	19	16	18	20	17	38	32
	Payloads	7	8	7	7	10	15	6	20	18	18	26	23	40	37	31	78	79
United States	Launches	24	16	12	17	18	14	23	15	17	13	19	22	18	22	29	34	21
	Payloads	25	14	17	32	35	18	35	35	27	27	79	43	49	59	255	183	235

59 in an Elliptical Orbit, and 590 in a Geostationary Orbit. Additionally, China conducted 64 orbital launches in 2022, placing a total of 217.39 tons of payload into orbit, and performed 67 orbital launches in 2023. Remarkably, China has consistently launched satellites and successfully placed them in orbit, suggesting a competitive pace with the U.S. It is evident that the number of satellites occupying Earth's orbit increased sharply during the Xi Jinping era.

However, even as the number of satellites launched by China approaches that of the U.S., disparities remain in actual space technological capabilities, particularly in the number of payloads per launch. As shown in Table 1, although China's payloads have doubled since 2015, the U.S. has already more than doubled, reaching a payload-to-launch ratio of 11.2:1 in 2019.

These data reveal several key points. First, while China has significantly increased its number of launches in recent years, the actual number of payloads placed in orbit still lags behind the U.S., indicating that China has not yet matched the U.S. in terms of efficiency or mission diversity. Second, the U.S. is capable of placing more payloads into orbit per launch, reflecting more advanced launch vehicle technology and the ability to deploy multiple satellites simultaneously. This suggests that China lags in its multi-payload launch capabilities. Third, the U.S.'s technological prowess is the result of long-term investment in research and development and active participation by private companies. Finally, while China has made rapid advancements in space technology, it has not yet reached the technical sophistication and operational capabilities of the U.S., indicating that China remains at an earlier stage in various areas of space technology. Overall, despite China's rapid development, a technological gap persists between China and the United States, with the U.S. maintaining superiority in payload numbers, launch efficiency, and years of R&D investment.

Strategic Factors in China's Space Technology Development

Self-Reliance and Xi Jinping's Space Technology Innovation Strategy

The rapid advancement of China's space technology cannot be attributed to a single factor. Instead, it should be seen as the result of an ecosystem formed by a combination of factors that foster and support innovation. This includes top-down leadership supporting the space program and a stable planning and financial system that provides continuous support for the last 15 years (Pollpeter, 2023: 114–112). Interestingly, China's space development focuses not only on science, technology, and political prestige but also on the amalgamation of military and economic interests. Under Xi Jinping's leadership these elements were strengthened and expanded to present a comprehensive vision of China's space strategy. Therefore, the enhancement of China's space technological capabilities can be seen as a reflection of Xi Jinping's leadership and China's desire to secure leadership in the global space sector (Eastin, 2023).

The strategic objectives of China's space strategy during the Xi Jinping era can be summarized as follows. First, Xi Jinping's leadership has clearly set the construction of space power as a long-term national goal. To achieve this, China is focusing on space exploration and technological innovation, and expanding its influence within the international space community (State Council Information Office of the People's Republic of China, 2022). Ultimately, Xi presented the vast exploration of space as a core objective of China's Space Program (Qisong, 2021: 785–807). China aims to achieve a dominant role in space by 2049 by extending its strategic superiority to the space domain. This includes not only military capabilities but also a "presence" of Chinese technology in key strategic positions within the Earth-Moon system (Davis, 2023: 74–89).

Xi Jinping's leadership has emphasized the role of space technology in various fields, including national security, economic development, scientific and technological innovation, and international cooperation. For instance, in China's "100 National Science and Technology Research Projects," the aerospace agenda prioritizes the future space industry ((State Council Information Office of the People's Republic of China, 2022; Ministry of Science and Technology of the People's Republic of China, 2016; SpaceNews, 2024). This includes the development of space-launch vehicle engines and the construction of space stations. The latest legislative processes related to the Financial and Economic Affairs Committee were approved by the Standing Committee of the National People's Congress during special sessions. This process is similar to that of the subcommittees in the U.S. Senate. Chinese laws are generally governed by the State Council and drafted and revised over several years, reflecting extensive academic and legal reviews and government opinions. Furthermore, the laws culminate in policy practices, regulatory tests, and pilot programs and can be seen as systematizing live policies that have been in place for years (Kenderdine, 2017: 325-

342).

Notably, China's space technology development during the Xi Jinping era progressed independently. This is partly due to the Wolf Amendment, which prohibits cooperation with U.S. space agencies. Passed by the U.S. Congress in 2011, the Wolf Amendment contains provisions that prohibit NASA and other space-related agencies operating with U.S. government funds from engaging in direct cooperation with the Chinese government or its affiliated organizations. This measure reflects concerns about the possibility of U.S. space technology being transferred to China and is evaluated as legislation that imposes significant constraints on space technology exchanges between the two countries (Young, 2019). However, U.S. sanctions against China have provided an opportunity for China to accelerate its own technology and innovation, and have opened up possibilities for cooperation with Europe (Winfrey, 2021). Since the passage of the Wolf Amendment, China has maintained space technology cooperation with Europe, and its domestic space ecosystem has developed almost independently. As mentioned earlier, China's space program began in 1956, accumulating 40 years of experience in the development of launch vehicles and spacecraft by the 1990s. However, China took considerable time to develop and operate major programs, such as manned spacecraft launches, satellite navigation, and lunar and Martian exploration, using its own technology. This delay was due to its inability to leverage the accumulated experience of the U.S. and the Soviet Union. In particular, the U.S. policy of technological sanctions against China, a major space power, became a significant turning point for China to develop its own technology independently (Pollpeter, 2023: 114–128).

Despite these constraints, China has made continuous efforts towards independent technological development. In 2003, China became the third country in the world to possess independent manned spaceflight capability through the successful launch of the Shenzhou 5 manned spacecraft using domestic technology. In 2011, China successfully launched the Tiangong-1 space station experimental module, propelling full-scale plans for space station construction. In 2020, China launched the Tianwen-1 Mars probe, successfully achieving Mars orbit insertion and rover landing, thereby significantly advancing its space exploration capabilities. These achievements have been pivotal in establishing China as a space power alongside the United States and Russia, further solidifying its position in global space competition through the development of independent technology and expertise.

Development of Space Technology Through Military-Civil Fusion

China's Military–Civil Fusion (MCF) strategy aims to strengthen the military technological capabilities of the People's Liberation Army and promote economic development by leveraging both civilian and military resources (Stone & Wood, 2020). This strategy was elevated to a national strategy in 2014 and is directed toward technological innovation and the strengthening of national defense (Fritz, 2021; Glaser, 2020; Levesque, 2021). To achieve these objectives, the MCF strategy comprises three main components: integration of defense technology and civilian industries, technological development and innovation, and policy support. The strategy promotes dual-use technologies that fulfill both military and commercial purposes, and plans and executes cooperation between civilian and state-owned defense enterprises (Stone & Wood, 2020). China is expanding its defense science and technology industry by developing advanced dual-use technologies for military purposes. Through this, China aims not only to strengthen national power but also to achieve self-reliance in space technology and enhance national competitiveness (Fritz, 2021).

In this context, the development of China's space industry is closely related to the MCF strategy, which has influenced the development of China's space technology by dividing it into technological and policy sectors. First, as part of its MCF strategy, China developed specific technologies. The People's Liberation Army determined the work and technological direction of civilian space companies. The previously mentioned Zhuhai satellite is a result of military-civil fusion, developed by the Harbin Institute of Technology, which has military affiliations, and was launched from the Wenchang Satellite Launch Center located in Wenchang, Hainan Province. Furthermore, the central government has deemed MCF as an important policy goal, building an industrial base that can support related technologies. China provides more financing and resources to startups that support space technology. Depending on the available resources and funding, companies adjust their activities based on the types of support they receive from various stakeholders for government priorities and survival, which will also change the development pattern of the space industry. Interestingly, no large-scale private space companies currently exist in China that encompass the entire space industry. Therefore, the only ways for dispersed companies to develop are to sell space-related products, raise funds from existing shareholders, and predict market movements (Winfrey, 2021).

China's MCF strategy has propelled space technology development in the following four ways: First, the MCF strategy has promoted the development of dual-use technologies, advancing technologies that can be utilized in both civilian and military applications. For example, the Beidou satellite system is used for both civilian and military purposes, enhancing China's positioning information system, while playing a crucial role in military operations (Stone & Wood, 2020). Second, the MCF strategy encourages the active participation of China's private enterprises in the development of military technology. The Beidou satellite system, developed through a collaboration between Alibaba and Norinco, is a representative example of civilian technology being converted into military technology. Through military-civil cooperation, China is simultaneously advancing various advanced technologies, such as artificial intelligence and big data, for both military and civilian uses (Fritz, 2021). Third, China promotes the development of various advanced technologies, including space technology, through its MCF strategies. For example, the Yaogan-41 optical imaging satellite operates in geostationary orbit. According to the Xinhua News Agency, this satellite can be used for land surveys, crop yield estimation, environmental management, weather warnings and forecasts, and comprehensive disaster prevention. Although this satellite is used for civilian purposes, it can also play a significant role in military applications. The Clayton Swope of the Centre for Strategic and International Studies mentioned that China could continuously conduct reconnaissance over the Pacific and Indian Oceans, Taiwan, and mainland China (Prasad & Shetty, 2024; Stone & Wood, 2020). Fourth, China is securing military superiority in space by developing and testing anti-satellite (ASAT) technologies using its MCF strategy. In 2007, China used an ASAT missile to destroy inactive weather satellites at an altitude of 800 km above Earth. This has brought about significant changes to military strategy in outer space (Stone & Wood, 2020). Thus, China showcased its space military capabilities to the world and demonstrated its ability to utilize civilian technologies militarily through the MCF strategy. In 2013, China launched a payload in space near Earth's orbit, reaching an apogee of over 30,000 km. Although no new satellite was launched from this payload, the flight path differed from that of existing space-launch vehicles, ballistic missiles, and research sounding rockets. This implies the basic capability of using ASAT technology against satellites in a geostationary orbit. Currently, the People's Liberation Army operates a ground-based ASAT missile system designed to target satellites in low-Earth orbit and continues to conduct related training. China plans to develop additional ASAT weapons capable of destroying satellites in a geostationary orbit (Prasad & Shetty, 2024).

In conclusion, the MCF strategy has accelerated space technology development by converting civilian innovations into military applications and vice versa. This includes advancements in satellite technology, rocket systems, and space exploration capabilities. Additionally, by ensuring the optimization and utilization of civilian and military resources through MCF, China has enhanced the efficiency and effectiveness of its space program. This strategy aims to build strong strategic capabilities by combining economic strength and national defense, thereby supporting China's space exploration and global leadership (Stone & Wood, 2020).

Space Technology Development Led by Private Enterprises and Local Governments

Participation of Chinese Private Enterprises in Space Technology

According to the U.S. Space Investment Report, since 2014, China has attracted the second largest amount of private capital in space enterprises, receiving investments from the private market, following the U.S. Approximately 28–29% of China's total investments in the private market are from private capital, compared with 46–48% in the U.S. (Bingen, 2024). This demonstrates that China is the second largest recipient of private capital investment after the U.S.

Since 2014, the Xi Jinping administration has progressively allowed private enterprises to participate in the space industry, resulting in increased corporate investment and the rapid development of commercial space technology in China. Fueled by government support, policy backing, and private investments, China's private space sector has grown. Starting in 2014, numerous aerospace start-ups were established in China, leading to technological innovations and successful rocket launches. Policies promoting space exploration and innovation include the Long March rocket launch, an increase in the number of orbiting satellites, and construction of the Tiangong space station. These developments have further invigorated participation in the private space sector, with private enterprises playing a significant role (CGTN, 2023; Winfrey, 2021).

The graph below illustrates the participation rates in China's private and commercial space technologies from 2014 to 2024. Private sector participation began at 0% in 2014 and surged to approximately 45% by 2024. This figure illustrates the rapid growth of China's private space industry.

China's private space industry emerged in 2014 and began to grow in earnest in 2015. During this period, China's commercial aerospace market showed significant potential, with the emerging industry achieving remarkable results worth one trillion yuan. According to research, China's commercial space market has experienced rapid growth since 2015, maintaining an average annual growth rate of over 20% between 2017 and 2024 (Li, 2024). According to the "China Aerospace Science and Technology Activities Blue Book, "published on February 26, 2024, of the 67 space launches in 2023, privately led launches accounted for 26, with a success rate of 96%. China has launched 120 commercial launch vehicles, representing 54% of the satellites launched annually (China Aerospace Science and Technology Corporation, 2023).

Amid this growth, China's private space industry will achieve significant technological breakthroughs in 2023, including multiple successful rocket launches and a focus on developing reusable rockets. Reusable rocket technology is a key factor for reducing launch costs and improving space accessibility. For example, the iSpace SQX-2Y and LandSpace Zhuque rockets focused on reusability. These rockets can verify recovery and reuse technologies at low altitudes and use cost-effective methane and liquid oxygen as fuels, facilitating engine and rocket maintenance (CGTN, 2023).

China has leveraged private enterprises to drive its space development through various strategies. The characteristics of China's private space sector are as follows. Chinese private space

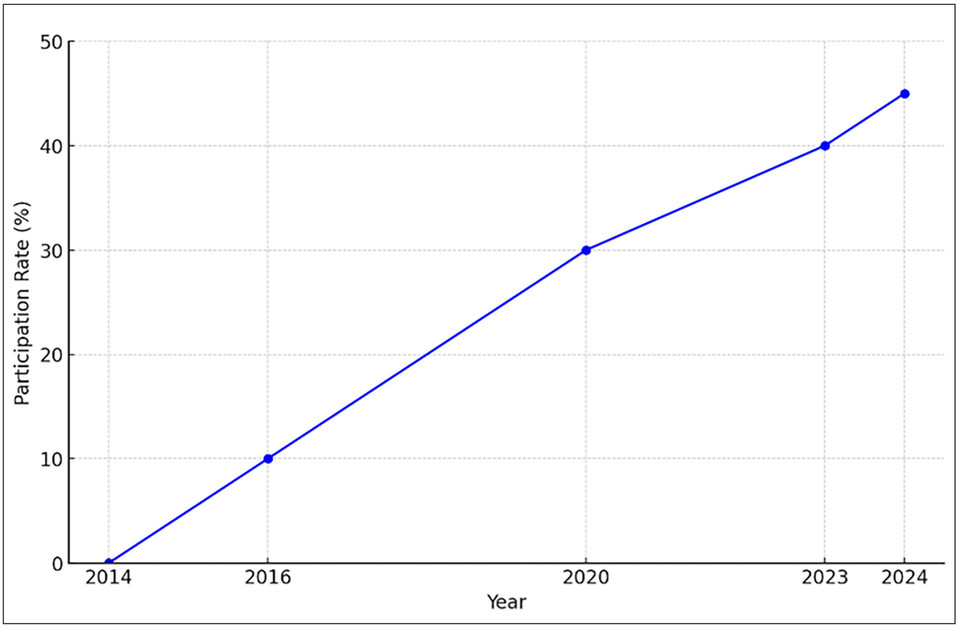

Figure 3. Participation Rate of China's Space Industry and Private Sector
Source: Reconstructed from Mark Stokes, Gabriel Alvarado, Emily Weinstein, and Ian Easton, "China's Space and Counterspace Capabilities and Activities," Project 2049 Institute, March 30, 2020.

companies are distinct from state-owned enterprises (SOEs); however, most receive development funds or other forms of state subsidies from local governments. Although this sector is still small, it is growing faster than SOEs, because nearly all private companies receive development funds or state subsidies from local governments. They generally receive at least 30% of their funding from private capital, with this ranging up 50%. The scale of funding depends on how much capital companies have raised over time because it is challenging for firms in this sector to generate profits. According to Euroconsult, a space industry consulting firm, China provided approximately 9 billion yuan ($1.3 billion) in funding to private companies in 2020 alone. This figure is estimated to have been 0 yuan in 2014 and approximately 4 million yuan in 2016 and 2017. China has approximately 120–150 commercial space companies, depending on how broadly space and private technologies are defined, with staff ranging from dozens to hundreds of employees. The private space sector is also rapidly growing in terms of securing space technology development personnel and funding, although this sector is smaller than the state-led project sector (Winfrey, 2021).

Thus, during the Xi Jinping era, China continued to develop its space industry by increasing its economic value through the commercial utilization of space technology. This aligns with the goals of generating economic benefits through space technology and achieving sustainable national development. Investments in space exploration and technological development drive economic growth, enabling more resources and funding for space programs. Therefore, China is increasing its investment in satellite technology, as its commercial and scientific applications, such as communications, weather forecasting, and Earth observations, are on the rise.

The development of China's space technology has been a key factor behind the unprecedented qualitative growth of the Chinese economy in recent decades. As a result, Chinese leadership emphasizes the importance of actively promoting space exploration and advancing new technologies aimed at utilizing space resources. Additionally, on June 29, 2019, Wu Yansheng, Chairman of the China Aerospace Science and Technology Corporation, declared at a special report meeting at Beihang University that China aimed to surpass the U.S. to become the world's leading space power. He stated that China, as a leading country in aerospace science and technology, would strive to elevate itself to the ranks of the world's space powers by 2030 and would possess the world's best and most original space products by 2045 to lead the global space industry (Hu, 2019).

Chinese private space companies drive China's space industry by adopting innovative operating methods, leading to a greater number of small-scale technological innovations rather than large-scale ones. For instance, while most private rocket companies focus on small- and medium-sized rockets, few concentrate solely on rocket engines and attempt to develop them using new types of fuel (Winfrey, 2021). The number of Chinese private space rocket companies varies slightly depending on the source; however, it is generally accepted that more than 20 major private space launch enterprises are active. Representative companies include iSpace, LandSpace, Galactic Energy, and Space Pioneer, all of which focus on the development of reusable rocket technology. These companies are developing solid- and liquid-fuel rockets, emphasizing their reusability to reduce launch costs and increase space accessibility (CGTN, 2023; Jones, 2023: 9; Xin, 2024).

Meanwhile, to promote technological innovation through private space ventures, China's National Development and Reform Commission (NDRC) released a list in April 2020 of new digital infrastructure projects it intends to invest in and build over the next decade or more. This list includes satellite Internet as a response to the rapid dominance of U.S. Starlink, which has launched numerous satellites since the end of 2019. The NDRC instructed local governments to build a satellite internet industrial base. This measure signifies that local governments are beginning to invest heavily in specific technologies designated as important by the central government, and that the space industry base is expanding to local regions (Winfrey, 2021).

Historically, all Chinese companies were state-owned and subordinate companies owned small subsidiaries of the same SOEs. However, this narrow supply base centered on SOEs is gradually changing and expanding. For example, the China Aviation Supplies Holding Company has a subsidiary called the Shanghai Academy of Spaceflight Technology, which has approximately 20,000 employees and 15 subsidiaries that manufacture rockets, satellites, and fuel tanks. Currently, the supply base of SOEs is broadening, with some top-tier suppliers, such as precision manufacturers, serving the aerospace and automotive industries, and showing more interest in the space sector. This indicates that although many private companies in China are subsidiaries or SOE spin-offs, the ecosystem is dominated by the government and SOEs.

Advancing the Space Industry through Private-Public Partnerships in Local Governance

On March 5, 2024, during the opening session of the National People's Congress, Premier Li Qiang included commercial aerospace as a major development sector for the Chinese government in his Government Work Report for the first time. This move aims to actively cultivate emerging and future industries, recognize commercial aerospace as an important national growth driver, and express commitment to support and nurture it. Until now, the development of China's space technology has been centrally planned and has relied on government budgets. While centralized space planning has the advantages of setting priorities for space technology development, allocating funds rationally, and providing stable support, it has the disadvantages of limiting innovative technology development by hindering a bottom-up research environment and investigator-centered research. To overcome these limitations, China has developed its space industry through private space enterprises, similar to the U.S.

Since 2014, China's space industry has allowed increasing commercial participation, and 120–150 private enterprises related to launch vehicles, satellite manufacturing, and space infrastructure have led China's space technology innovation, with this trend continuing and expanding. Proponents of private space enterprises argue that market efficiency provides a more favorable environment for promoting innovation in the private sector. Moreover, the private space industry complements rather than replaces the state-owned sector. China's space technology policies promoting innovation have led to various achievements, including the development of high-performance launch vehicles and the construction of space stations. Various space technology projects from private space enterprises, which have not received national attention, have played a central role in China's space technology supply chain. This highlights the potential of the private sector to contribute to space technology development through innovation and efficiency.

Since 2014, more than 200 private space enterprises have been established in China. Under Xi Jinping's leadership, China's space industry has seen a significant increase in commercial participation, with growth particularly pronounced during his administration. This expansion is closely related to changes in the Chinese government's private investment policies, and almost all space projects have been led by state-owned enterprises such as the China Aerospace Science and Technology Corporation and the China Aerospace Science and Industry Corporation (Curcio, 2022).

As mentioned previously, until 2014, China's space industry was entirely a domain of state-owned enterprises. However, in 2015, the State Council released the "Medium- and Long-Term Development Plan for Civil Space Infrastructure 2015–2025," which called for more private investment in areas such as launch vehicle and satellite manufacturing, opening the way for private participation in the space industry. In the initial implementation period of 2015–2016, only a few private space companies were established, partly due to uncertainties regarding private investment in the space sector. However, over the next two to three years, government support plans were announced, creating an environment in which investors and stakeholders could invest stably, leading to the development of the space industry. Currently, China's private space enterprises are contributing to more active long-term space industry activities, including vehicle launches, satellite orbit insertion, and the construction of the Tiangong Space Station.

The central government has made space exploration and technological development national priorities, and local governments have sought to develop regional economies and promote technological innovation through advancements in this field. In particular, local governments create highly specialized industrial parks or innovation hubs to attract space technology companies, research institutes, and start-ups. Through these efforts, private space companies are provided with a foundation to conduct R&D and commercialize new technologies. Landspace is a representative example. Founded in 2015, the company is nearly ready to launch a rocket with a payload capacity of 2 tons into low-Earth orbit. In its early stages, Landspace received a large plot of land free of charge from Huzhou City to build a rocket industrial base, as well as 200 million yuan in funding. Similarly, many local governments in China, aiming to attract launch vehicle or satellite companies, offer land and financial support to foster research and development (Winfrey, 2021).

Notably, almost all private companies receive funding from local governments or national subsidies. Therefore, private space enterprises generally operate with at least 30% of their funding sourced from private capital and, in many cases, up to 50%. The scale of private space enterprises depends on how much funding they have raised over a certain period, during which initial profit generation is challenging. One of the biggest factors enabling the development of China's private space enterprises is the full support of local governments. While the central government devises macro-level space plans, local governments support private space enterprises and companies, establishing mutually complementary symbiotic relationships that promote regional development and continue technological innovation in a stable financial environment. Full support from local governments has led to growth of the private space sector, which plays an important role in the development of China's space technology. Private space enterprises have been able to develop by receiving space development funds from local governments and national support. Additionally, the private space sector is relatively small compared to state-owned enterprises but is growing rapidly, becoming an important driving force for space technology and innovation (Winfrey, 2021).

Examining the funding ratio of China's space industry, as shown in Figure 4, it is evident that local governments have been providing continuous financial support to private enterprises. Except in 2016, private enterprise funding surpassed that of the central government, and since 2018, local government support has also taken the lead. When localities attract companies, local governments promote corporate growth and technological innovation by providing financial support, tax reductions, and other incentives to private space enterprises. This can help companies allocate more resources to R&D and attempt new projects. Additionally, local governments can collaborate with universities to cultivate space technology experts. Through this, they have secured the skilled workforce necessary for the space industry within the region and have developed while supporting innovation in the field of space technology through a cyclical structure.

Meanwhile, China also supports universities developing commercially viable satellites to help establish companies. This strategy often involves the university becoming a shareholder in the company or forming a similar relationship to provide funding and technical support. For example, Zhuhai-1, launched in 2019, was developed under the leadership of the Harbin Institute of Technology, and the launch vehicle was developed by the China Academy of Launch Vehicle Technology. The satellite was launched by Zhuhai Orbita Aerospace Science & Technology Co.,

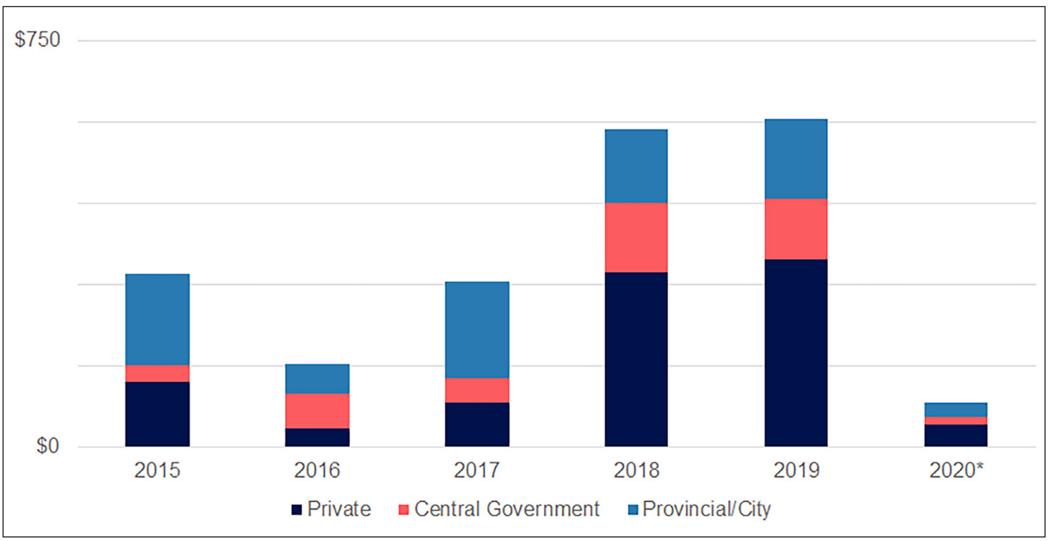

Figure 4. Funding Ratio of China's Space Industry (2015–2020)
Source: Novaspace. "Private investment fuels China commercial space sector growth, alongside state-backed investment." June 4, 2020.

Ltd. (Xinhua, 2019).

Most importantly, local governments are driving the development of the space industry by effectively implementing central space industry policies at the regional level and adjusting and applying them to suit regional characteristics. They also support and encourage the space industry in various ways to achieve regional economic benefits and technological innovation.

An unusual fact here is that even though some companies appear to be private on the surface, they are private enterprises spun off from state-owned enterprises and thus reflect the influence of the central government. For example, China's first private remote sensing and space company, Changguang Satellite Technology Co., Ltd., established on December 1, 2014, was originally spun off from the Changchun Institute of Optics, Fine Mechanics, and Physics at the Chinese Academy of Sciences. Their research team at the Department of Optical Precision Mechanical Engineering has been collaborating on remote sensing satellite research and development for over ten years. Additionally, commercial satellite manufacturers that emerged in the late 2010s, such as MinoSpace, Spacety, and Galaxy Space, were former employees of the China Aerospace Science and Technology Corporation. These companies primarily focus on satellites and launch vehicles and have mostly strived to sell them to state-owned enterprises, universities, and the government. First-generation private space ventures have the advantage of being able to flexibly promote the development of space technology according to local conditions. For instance, because industrial regulations for satellite manufacturers in local areas are unclear, they can develop terminals and applications. Newly established private space enterprises exist in multifaceted systems with various stakeholders. Several competitive companies have emerged in China's space sector, and if government support is strengthened at various levels, more such companies will appear in the future (Curcio, 2022).

Launch centers distributed throughout China contribute significantly to local technological development as major platforms of China's space program and strengthen space launch capabilities by differentiating functions according to the purposes of the launched satellites. Currently, China's satellite launch centers are located in Jiuquan, Gansu Province; Xichang, Sichuan Province; Taiyuan, Shanxi Province; Wenchang, and Hainan Province. The Haiyang Centre in Shandong Province is currently under construction. The Jiuquan Satellite Launch Center is the oldest launch center, located in the Inner Mongolia Autonomous Region, and primarily launches low-Earth and sun-synchronous orbit satellites. The Xichang Satellite Launch Center is located in Xichang City, Sichuan Province, and is primarily used to launch geostationary orbit satellites. Third, the Taiyuan Satellite Launch Center is located near Taiyuan in Shanxi Province and is primarily used for launching low-Earth and sun-synchronous orbit satellites. Fourth, the Wenchang Satellite Launch Center, established in Hainan in 2016, was used for China's large carrier rockets and orbital transfer missions.

These launch centers, spread across China, not only expand the range of satellite launches but also play a crucial role in enhancing international recognition and attracting investment, in addition to their direct impact on the regional economy. The space industry is a rapidly growing field that has the potential to create economic benefits by enabling the development of new technologies and services. The establishment and operation of space launch centers require substantial initial investments that can promote job creation, infrastructure development, and the advancement of other industries and services within the region. Accordingly, launch centers have positive direct and indirect impacts on the regional economy by bringing in highly skilled personnel and enhancing scientific and technological capabilities. This unique structure of China's space industry has contributed to the rapid development of space technology and industry at the national level.

Conclusion

Since Xi Jinping assumed leadership in 2013, China has emerged as a formidable competitor in space technology, challenging the U.S.' long-standing dominance. While the U.S. has maintained its leadership in key areas such as reusable launch vehicle technology and satellite operations, which drive innovation and reduce costs, China's strategic investments have dramatically altered the dynamics of global space competition. The construction of the Tiangong Space Station, successful Martian and lunar missions, and the expansion of a robust satellite network symbolize China's ambition to establish itself as a leading space power.

China's remarkable progress in space technology has been shaped by external constraints and internal strategic imperatives. U.S. restrictions on space technology transfers have catalyzed China's pursuit of self-reliance and technological independence, marking a transition from experimental programs under Hu Jintao to the large-scale operational capabilities of the Xi era. A critical turning point was the Chinese government's 2014 policy that encouraged private sector participation, spurring innovation, and the proliferation of aerospace startups. The integration of private enterprises, supported by local governments and financial incentives, has significantly enhanced China's overall technological capabilities.

The Military-Civil Fusion strategy has further reinforced China's progress by fostering dual-use technologies that serve both civilian and military objectives. The Beidou Satellite System epitomizes this approach, bolstering national security while supporting critical infrastructure. This strategic framework underscores China's ability to integrate resources across sectors to sustain its competitive edge despite continued external restrictions.

China's space program is not merely a technological endeavor but also a tool for advancing its geopolitical and diplomatic goals. Initiatives such as the "Space Silk Road" have deepened partnerships with developing nations, expanding China's influence within the global space order. Furthermore, China's capabilities provide opportunities to engage in multilateral solutions to shared challenges, including space-debris mitigation, climate change, and deep-space exploration.

Despite these achievements, China faces significant challenges in sustaining its momentum. Continued funding, talent cultivation, and regulation of the rapidly growing private aerospace sector are critical for maintaining progress. Additionally, China must navigate the intensifying international scrutiny regarding the militarization of space and compliance with global space governance norms. These challenges highlight the intricate balance between advancing national ambitions and aligning them with the expectations of the international community.

Looking ahead, China's space ambitions are poised to grow through initiatives such as lunar base construction, Martian exploration, and space resource utilization. By enhancing existing infrastructure, such as the Beidou system, and fostering innovation in key areas, such as reusable rockets and space manufacturing, China is strategically positioning itself to shape the future of global space governance.

In conclusion, China's rapid advancements in space technology during the Xi Jinping era were rooted in a confluence of factors: visionary leadership, private sector integration, local government support, the Military–Civil Fusion strategy, and consistent investments in research and development. These elements collectively underscore the political, economic, and strategic dimensions of China's space program, illustrating how it serves as both a symbol and instrument for China's ascent as a global power. China's expanding influence in space is likely to redefine the contours of global space governance, reinforcing its status as a pivotal actor in the international system.

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Conflicting Interests

I declare that I have no conflicts of interest in this research.

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